

Appl. No. 09/663,582

Amendment Dated: October 28, 2003

Reply to Office action of July 30, 2003

In the Claims:

Claim 1 (Currently Amended). A composite material,
comprising:

a ceramic matrix consisting of phases of silicon, carbon, and
silicon carbide; and

fiber bundles having two different fractions including a
reinforcing fiber bundle fraction and a matrix fiber bundle
fraction having lengths with different averages, each of said
fiber bundles having a weight, said weights being proportional
to said fiber bundle lengths, said weights being plotted to a
graph of weight distribution versus fiber bundle length, said
graph exhibiting a minimum between a first part of said
distribution graph relating to said reinforcing fiber bundle
fraction and a second part of said distribution graph relating
to said matrix fiber bundle fraction on a total fiber bundle
distribution, and said fractions of fiber bundles being
separated by a minimum in said total fiber bundle
distribution;

a portion of said fiber bundles having at least one protective
layer.

Claim 2 (Canceled).

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Claim 3 (Previously Presented). The composite material according to claim 1, wherein said fiber bundles contain fibers selected from the group consisting of carbon fibers, graphite fibers, SiC-fibers, aluminum oxide fibers, $\text{Al}_2\text{O}_3\text{SiO}_2$ -fibers, $\text{Al}_2\text{O}_3\text{SiO}_2\text{B}_2\text{O}_3$ -fibers, carbonized cellulose fibers, carbonized wood fibers, and fibers resistant to elevated temperatures based on compounds containing Si, C, B, N, Al.

Claim 4 (Previously Presented). The composite material according to claim 1, wherein said fiber bundles contain at least one of nano fibers, whiskers, and nanotubes.

Claim 5 (Currently Amended). The A composite material according to claim 1, wherein , comprising:

a ceramic matrix consisting of phases of silicon, carbon, silicon carbide, and said ceramic matrix additionally contains phases of at least one of aluminum, zirconium, silicon nitride, boron nitride, boron carbide, SiBCN, Al_2O_3 , ZrO_2 , TiC, and iron silicides; and

fiber bundles having two different fractions including a reinforcing fiber bundle fraction and a matrix fiber bundle fraction having lengths with different averages, each of said fiber bundles having a weight, said weights being proportional to said fiber bundle lengths, said weights being plotted to a

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graph of weight distribution versus fiber bundle length, said
graph exhibiting a minimum between a first part of said
distribution graph relating to said reinforcing fiber bundle
fraction and a second part of said distribution graph relating
to said matrix fiber bundle fraction.

Claim 6 (Currently Amended). The A composite material
~~according to claim 5, wherein~~ , comprising:

a ceramic matrix consisting of phases of silicon, carbon,
silicon carbide, and at least one of aluminum, zirconium,
silicon nitride, boron nitride, boron carbide, SiBCN, Al₂O₃,
ZrO₂, TiC, iron silicides, and said ceramic matrix contains
additions selected from the group consisting of iron,
chromium, titanium, molybdenum, and nickel; and

fiber bundles having two different fractions including a
reinforcing fiber bundle fraction and a matrix fiber bundle
fraction having lengths with different averages, each of said
fiber bundles having a weight, said weights being proportional
to said fiber bundle lengths, said weights being plotted to a
graph of weight distribution versus fiber bundle length, said
graph exhibiting a minimum between a first part of said
distribution graph relating to said reinforcing fiber bundle
fraction and a second part of said distribution graph relating
to said matrix fiber bundle fraction.

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Claim 7 (Original). The composite material according to claim 5, wherein said fiber bundles are carbon and graphite fiber bundles.

Claim 8 (Canceled).

Claim 9 (Original). The composite material according to claim 1, including a fraction of overlong fiber bundles, in addition to said reinforcing fiber bundle fraction and said matrix fiber bundle fraction.

Claim 10 (Original). The composite material according to claim 1, wherein at least one of said reinforcing fiber bundle fraction and said matrix fiber bundle fraction are composed of several fiber bundle fractions with different average fiber bundle lengths.

Claim 11 (Original). The composite material according to claim 1, wherein said average fiber bundle length of said reinforcing fiber bundle fraction is between 4 mm and 20 mm.

Claim 12 (Original). The composite material according to claim 1, wherein said average fiber bundle length of said matrix fiber bundle fraction is between 0.2 mm and 5 mm.

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Claim 13 (Original). The composite material according to claim 1, wherein said reinforcing fiber bundle fraction has an average fiber bundle width between 0.02 mm and 5 mm.

Claim 14 (Original). The composite material according to claim 1, wherein said matrix fiber bundle fraction has an average fiber bundle width between 0.02 mm and 2 mm.

Claim 15 (Original). The composite material according to claim 1, wherein a ratio of said average fiber bundle length of said reinforcing fiber bundle fraction to said average fiber bundle length of said matrix fiber bundle fraction is between 1.5 and 10.

Claim 16 (Original). The composite material according to claim 1, wherein a ratio of said average fiber bundle length of said reinforcing fiber bundle fraction to an average fiber bundle width of said reinforcing fiber bundle fraction is between 2 and 500.

Claim 17 (Original). The composite material according to claim 1, wherein a ratio of said average fiber bundle length of said matrix fiber bundle fraction to an average fiber bundle width of said matrix fiber bundle fraction is between 2 and 500.

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Claim 18 (Original). The composite material according to claim 1, wherein said reinforcing fiber bundle fraction has an average length/width/height ratio of between 2 and 50,000.

Claim 19 (Original). The composite material according to claim 1, wherein said matrix fiber bundle fraction has an average length/width/height ratio of between 2 and 50,000.

Claim 20 (Original). The composite material according to claim 1, wherein a ratio of a weight of said matrix fiber bundle fraction to a weight of all fiber bundles is between 0.1 and 0.8.

Claim 21 (Currently Amended). The composite material according to claim 1, wherein said reinforcing fiber bundle fraction has a width at half maximum of said first part of said graph relating to said reinforcing fiber bundle fraction ~~a fiber bundle length distribution of~~ between 0.01 mm and 15 mm.

Claim 22 (Currently Amended). The composite material according to claim 1, wherein said matrix fiber bundle fraction has a width at half maximum of said second part of said graph relating to said matrix fiber bundle fraction ~~a fiber bundle length distribution of~~ between 0.01 mm and 5 mm.

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Claim 23 (Withdrawn). In a method for manufacturing composite materials reinforced with fiber bundles and having a ceramic matrix, the improvement which comprises:

providing two different fractions of the fiber bundles including a reinforcing fiber bundle fraction and a matrix fiber bundle fraction with different average fiber bundle lengths, as basic materials; and

providing a total fiber bundle distribution as a function of a length of the fiber bundles with a minimum between the average fiber bundle lengths of the reinforcing fiber bundle fraction and the matrix fiber bundle fraction.

Claim 24 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises initially mixing the two different fractions of fiber bundles, subsequently pressing the mixed fractions of fiber bundles into a molded body, and then infiltrating the molded body with polymers.

Claim 25 (Withdrawn). The method for manufacturing composite materials according to claim 24, which further comprises infiltrating further fillers in addition to the polymers.

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Claim 26 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises adding the two different fractions of fiber bundles to other components during a mixing process to form a mixture.

Claim 27 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises providing at least a portion of the fiber bundles at least in part with at least one protective layer.

Claim 28 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises using only carbon and graphite fiber bundles.

Claim 29 (Withdrawn). The method for manufacturing composite materials according to claim 26, which further comprises using only carbon and graphite fiber bundles.

Claim 30 (Withdrawn). The method for manufacturing composite materials according to claim 26, which further comprises mixing the two different fractions of fiber bundles with at least one carbonizable binder during the mixing process.

Claim 31 (Withdrawn). The method for manufacturing composite materials according to claim 28, which further comprises

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mixing the two different fractions of fiber bundles with at least one carbonizable binder during the mixing process.

Claim 32 (Withdrawn). The method for manufacturing composite materials according to claim 31, which further comprises selecting a binder from the group consisting of resins and pitches as the at least one carbonizable binder.

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Claim 33 (Withdrawn). The method for manufacturing composite materials according to claim 32, which further comprises compressing the mixture after the mixing step.

Claim 34 (Withdrawn). The method for manufacturing composite materials according to claim 33, which further comprises carrying out the compressing step at an elevated temperature.

Claim 35 (Withdrawn). The method for manufacturing composite materials according to claim 33, which further comprises subjecting the molded body after the compressing step to a temper process above a curing temperature of resin binders in the mixture.

Claim 36 (Withdrawn). The method for manufacturing composite materials according to claim 34, which further comprises carbonizing the at least one carbonizable binder in a further process step.

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Claim 37 (Withdrawn). The method for manufacturing composite materials according to claim 36, which further comprises carrying out graphitization at temperatures above 2000 °C as a further process step.

Claim 38 (Withdrawn). The method for manufacturing composite materials according to claim 36, which further comprises carrying out siliconizing in a final process step.

Claim 39 (Withdrawn). The method for manufacturing composite materials according to claim 37, which further comprises carrying out siliconizing in a final process step.

Claim 40 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises setting the average fiber bundle length of the reinforcing fiber bundle fraction to between 4 mm and 20 mm.

Claim 41 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises setting the average fiber bundle length of the matrix fiber bundle fraction to between 0.2 mm and 5 mm.

Claim 42 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises setting a ratio of the average fiber bundle length of the

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reinforcing fiber bundle fraction to the average fiber bundle length of the matrix fiber bundle fraction to between 1.5 and 10.

Claim 43 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises setting an average length/width/height ratio of the reinforcing fiber bundle fraction to between 2 and 50,000.

Claim 44 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises setting an average length/width/height ratio of the matrix fiber bundle fraction to between 2 and 50,000.

Claim 45 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises mixing the two fractions of fiber bundles to form a mixture, and setting a combined weight fraction of the fiber bundles of the two fiber bundle fractions used in the mixing step to 50 to 99 % of a total weight of the mixture.

Claim 46 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises mixing the two fractions of fiber bundles to form a mixture, and setting a weight fraction of the fiber bundles of the

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reinforcing fiber bundle fraction used in the mixing step to 20 to 80 % of a total weight of the mixture.

Claim 47 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises mixing the two fractions of fiber bundles to form a mixture, and setting a weight fraction of the fiber bundles of the matrix fiber bundle fraction used in the mixing step to 10 to 40 % of a total weight of the mixture.

Claim 48 (Withdrawn). The method for manufacturing composite materials according to claim 23, which further comprises setting a ratio of a weight of the matrix fiber bundle fraction to a weight of all of the fiber bundles at between 0.1 and 0.8.

Claim 49 (Withdrawn). A method for manufacturing gas turbine parts, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 50 (Withdrawn). A method for manufacturing parts of burners, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

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Claim 51 (Withdrawn). A method for manufacturing nozzles and nozzle parts, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 52 (Withdrawn). A method for manufacturing hot-gas pipes, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 53 (Withdrawn). A method for manufacturing measuring probes, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 54 (Withdrawn). A method for manufacturing jacket tubes for probes, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 55 (Withdrawn). A method for manufacturing brake-discs for aircraft, rail vehicles and motor vehicles, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

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Claim 56 (Withdrawn). A method for manufacturing brake-discs for aircraft, rail vehicles and motor vehicles, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 8.

Claim 57 (Withdrawn). A method for manufacturing brake-linings for aircraft, rail vehicles and motor vehicles, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 58 (Withdrawn). A method for manufacturing brake-linings for aircraft, rail vehicles and motor vehicles, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 8.

Claim 59 (Withdrawn). A method for manufacturing thermal shields, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 60 (Withdrawn). A method for manufacturing thermal protective components of spacecraft and aircraft engines, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

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Claim 61 (Withdrawn). A method for manufacturing components of sliding bearings and sliding elements, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 62 (Withdrawn). A method for manufacturing components of sliding bearings and sliding elements, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 8.

Claim 63 (Withdrawn). A method for manufacturing carrier components for mirrors, antennas and reflectors, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 64 (Withdrawn). A method for manufacturing missile components, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

Claim 65 (Withdrawn). A method for manufacturing fire grates, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

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Claim 66 (Withdrawn). A method for manufacturing components of heat exchangers, which comprises providing a composite material reinforced with fiber bundles and having a ceramic matrix according to claim 1.

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Claim 67 (Previously Presented). The composite material according to claim 1, wherein said phases of silicon in said ceramic matrix are elemental silicon.

Claim 68 (Previously Presented). The composite material according to claim 1, wherein said phases of carbon in said ceramic matrix are elemental carbon.
